

Introduction

Chapter Overview

Among the diverse goals of the U.S. higher education system, two are particularly important to the science and engineering (S&E) fields. In addition to enhancing the broad intellectual capabilities of students, higher education prepares students to meet the needs of the 21st-century workforce. With the decline in the U.S. college-age population from 1980 to 1997 and subsequent falloff in degrees in many S&E fields, U.S. universities began to rely on foreign students to fill graduate S&E programs, particularly in the physical sciences, engineering, and computer sciences. As national demographic trends shift and minority populations become a larger proportion of the college-age cohort, U.S. higher education institutions are being challenged to attract and retain minority students who have been underrepresented in the S&E fields.

The U.S. higher education system also is responding to a growing movement across countries to enlist universities more explicitly into national innovation systems. For several decades, many countries have strengthened their higher education in S&E fields as a strategy for development, based on an assertion that advanced S&E knowledge would bolster their economies. In the 1990s, this assertion gained widespread acceptance, and most industrial and developing countries began improving their higher education systems, particularly in natural sciences, mathematics, engineering, and technology, as a necessary part of preparing for a “knowledge economy.” Indicators of this international movement toward science and technology (S&T) education for development are:

- ◆ increased growth rate in the number of degrees in S&E fields among industrialized countries and developing nations,
- ◆ increased flow of foreign graduate students to study S&E fields in advanced countries,
- ◆ increased recruiting of foreign students by advanced countries that have a declining college-age population, and
- ◆ expanded options for mobility by foreign S&E doctorate-holders in terms of remaining abroad, returning home, or circulating between home and abroad during their careers.

As higher education in the United States contributes to these international trends¹ and also attempts to better prepare U.S. students for S&E careers, various changes are taking place:

- ◆ The infrastructure for S&E education is expanding beyond the traditional institutions of higher education to an array of flexible and interconnected learning modes.
- ◆ The scope of concern in S&E education is expanding to include both the focused education of S&E majors and the goal that all college students acquire scientific and technical literacy.
- ◆ The delivery of S&E instruction is changing through new teaching methods and innovative uses of information technology (IT).
- ◆ Student strategies for acquiring knowledge are changing to incorporate both traditional and new modes of higher education delivery.
- ◆ The growing proportion of underrepresented minority groups in the student body is forcing a movement to raise their participation in S&E.

Chapter Organization

The chapter begins with U.S. higher education and traditional education indicators of enrollment and degrees in S&E fields in different types of institutions. Overall demographic trends are discussed, including trends among U.S. subpopulations that are increasing minorities among the college-age cohort. The chapter describes traditional and new mechanisms for delivering higher education in S&E fields and, when possible, quantifies the activity outside formal academic institutions. For each level of higher education, enrollment and degrees are analyzed by sex, race/ethnicity, and citizenship. The chapter provides indicators of U.S. undergraduate students’ initial interest in studying S&E, the persistent need during the past 20 years for remedial coursework, and the recently declining number of degrees in most S&E fields at all levels within traditional institutions of higher education. Efforts to reform undergraduate education aimed at raising the quantity and quality of U.S. students in S&E fields and at meeting all student needs for quantitative and scientific understanding are discussed. The chapter highlights trends in U.S. graduate S&E education and discusses reforms that attempt to broaden education and career options. Changing patterns of mobility and reverse flow of foreign students also are discussed.

The final section describes global trends that place U.S. higher education in an international context. For example, cross-regional trends in S&E degrees conferred show the acceleration of such degrees at the bachelor’s and doctoral levels. The stronger participation rates in S&E among college-age cohorts in Europe and Asia are contrasted with participation rates in the United States. The flow of foreign students to the United States is compared with the increasing flow to the United Kingdom and Japan. The reverse flows of foreign doctorate-holders by field and country of origin are compared across the United States, United Kingdom, and France.

¹U.S. institutions and S&E faculty are active in international distance education in developing countries, advise on establishing centers of excellence, accept students from abroad, and establish international collaborative research with their former students. (See, for example, Michael Arnon, 2001, “U. of Maryland Will Help Uzbekistan Create a Virtual University,” *The Chronicle of Higher Education*, August 29; Eugene S. Takle, “Global Climate Change Course,” Iowa State University, International Institute of Theoretical and Applied Physics, available at <<http://www.iitap.iastate.edu/gccourse>>; and E.S. Takle, M.R. Taber, and D. Fils, “An Interdisciplinary Internet Course on Global Change for Present and Future Decision-makers,” Keynote presentation at the International Symposium on the Learning Society and the Water Environment, Paris, June 2–4, 1999.)